

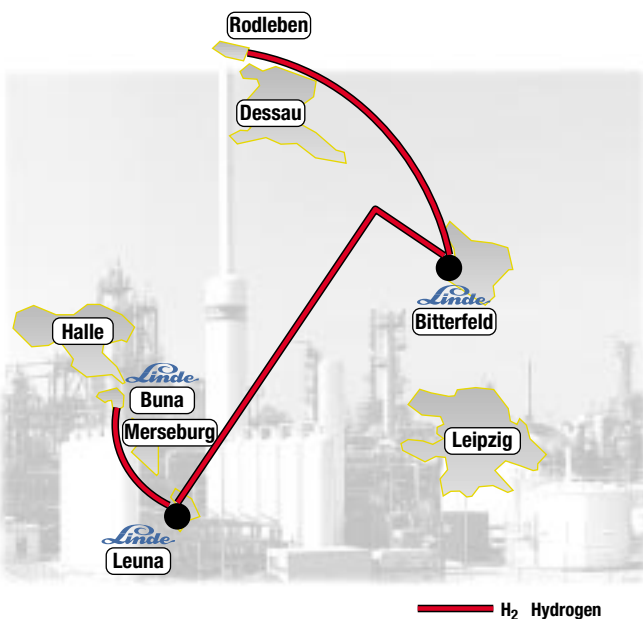
HYDROGEN – Energy Carrier of the future





Linde steam-reformer, Milazzo, Italy

Hydrogen is generally considered as the potential energy carrier of the future, replacing traditional hydrocarbon-based energy sources by renewable ones in the long term. But even today under special niche-conditions, hydrogen produced for instance by electrolysis already can be economical and thus make hydrogen attractive as fuel for mobile applications. New hydrogen applications for fuel cells will gain an additional share in the hydrogen market which is presently dominated by the chemical and refining industry.



Linde H₂ pipeline network, Leuna, Germany

Linde has both the capabilities for designing and constructing hydrogen plants as well as operating them with its own staff, thus supplying customers with hydrogen and also other industrial gases in all desired capacity ranges.

Production

The industrial process most commonly used nowadays for the large-scale production of hydrogen is "steam-reforming". Linde has worldwide built numerous steam reforming plants with capacities ranging from appr. 1,000 to 100,000 Nm³/h H₂. At Leuna, Germany, and Milazzo, Sicily, Linde supplies refineries and a whole industrial complex with hydrogen from its own large capacity on-site plants. Additional reformers in France and Germany operated by Linde will come onstream at the beginning of 2000. In the US, at LaPorte Texas, Linde is supplier of syngas to Millenium Chemicals located in the largest petrochemical industrial complex of the world.



Linde liquefier, Ingolstadt, Germany

Liquid hydrogen (LH₂) occupies a position of particular importance due to the considerably higher density in comparison to gaseous hydrogen thus making it very attractive from the logistical and storage point of view. Especially for mobile and aerospace applications liquid hydrogen has become an interesting fuel. Linde has built hydrogen liquefiers in Canada, India, Japan and China and is operating Germany's only industrial scale LH₂ production plant with a 4.4 t/d liquefaction capacity at Ingolstadt, Germany.

Distribution and Logistics

Cost-effective hydrogen production is just “one side of the coin”. The other side is the transport of the hydrogen from the production plant to the consumer. Linde logistics covers all kinds of transport from small hydrogen cylinders up to large-scale pipeline networks. In the chemical area of Leuna Linde operates Europe’s most modern pipeline system for hydrogen. Customers with a demand for a GH₂/LH₂ on-site storage system receive hydrogen from special high pressure gas trailers or liquid tankers.



LH₂ fuel station, Munich, Germany

At the Munich airport Linde has built in collaboration with MAN, BMW, Aral and other partners the world’s first public fuel station for liquid hydrogen. As a novelty the filling of the LH₂ car-tanks happens fully automatically with a robot. In a parallel operation gaseous high pressure hydrogen is supplied to shuttle buses conveying passengers at the airport. Furthermore Linde is engaged in a concept study investigating the hydrogen infrastructure of airports for DaimlerChrysler Aerospace.



LH₂ fuel station for MAN City Bus, Erlangen, Germany



“NECAR4” fuel cell car from Daimler Chrysler with Linde LH₂ tank

Mobile and other Applications

In different hydrogen research projects Linde has been engaged from the very beginning. Linde participated in the joint venture of the “Solar-Wasserstoff-Bayern GmbH” in Germany, where the essential components for a solar hydrogen system were investigated. For the European “Ariane” rocket Linde built the hydrogen infrastructure for the test facilities of the “Vulcain” engine.



BMW research vehicle with Linde LH₂ tank

For mobile applications such as different bus and passenger car projects Linde has been providing liquid hydrogen tanks and systems. Linde has been the cryogenic partner for several generations of BMW research vehicles as well as for the latest fuel cell car “NECAR 4” from DaimlerChrysler. For a stationary fuel cell cogeneration plant at Hamburg, Germany, Linde took care of the hydrogen infrastructure and necessary approvals for the LH₂-storage. This FC-unit was installed amidst a public residential district requiring the application of high safety standards.

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Linde AG
Industrial Gases Division
Seitnerstraße 70
D-82049 Höllriegelskreuth
phone +49 89 7446-0
fax +49 89 7446-1230
<http://www.Linde.com/Linde-Gas>

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